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PRELIMINARY

HAND-HELD DIGITAL MULTIMETERS

HD 151, 152, 153

2.22, 223

SERVICE MANUAL

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1.00 GENERAL INFORMATION

The HD 150 Series digital multimeters feature compact, heavy duty design for easy portability and long service life. Their fully gasketed, water and fire resistant construction insures the meters ruggedness in the most hostile environment.

1.10 FEATURES

The HD150 series features all the basic functions required for the most demanding of customers among these are:

- o Compact Heavy Duty Design
- o Auto/Manual Ranging
- o Audible Readout (HD153)
- o Automatic Off
- o Dangerous Voltage Present
- o Logic Function (HD153)
- o Tilt Stand Sky Hook

1.11 CALIBRATION

A QUICK CALIBRATION MUST BE PERFORMED ON THE METER AFTER COMPONENT REPLACEMENT WHICH CONSISTS OF THE FOLLOWING:

WITH THE METER IN DC VOLTS, INPUT 190.0 mV DC FROM AN ACCURATE SOURCE AND ADJUST R12 FOR A DISPLAY READING OF EXACTLY 190.0mV DC. WITH THE METER IN AC VOLTS, INPUT 190.0mV AT 700 HZ AND ADJUST R7 FOR A DISPLAY OF 190.0 mV AC. METER CALIBRATION IS NOW COMPLETE.

1.12 CURRENT DRAW SPECIFICATIONS

ON CURRENT DRAW SHOULD BE LESS THAN 1.2 mA DC

OFF CURRENT (QUIESCENT CURRENT) DRAW SHOULD BE NON-RAMPING AND LESS THAN 10 µA

2.00 THEORY OF OPERATION

The heart of the HD150 Series digital multimeter is the analog microprocessor chip (APC) which is used in conjunction with a microcomputer to form the analog to digital converter (A/D). The A/D converts DC inputs to digital equivalents, which are then displayed on the liquid crystal display (LCD).

Peripheral components are used in conjunction with the A/D chip to enable the meter to perform voltage, current and resistance measurements.

2.10 DC VOLTAGE MEASUREMENT

2.11 Input Amplifier - The input aplifier's role is to buffer and scale the DC input to be within the A/D integraters input range of +/- 300mV. The input amplifier is configured as an inverting amplifier with selectable gain settings depending upon the DC input magnatude.

2.12 Normal Mode Filter - The normal mode filter (NMF) is used to remove unwanted noise that may be present on the scaled DC input before it is applied to the A/D chip.

2.13 Analog to Digital Coversion - The coversion takes five steps. The first two are used to remove offsets internal to the A/D input amplifier and set the integrator output to a "reference zero" prior to signal integrate. The third is signal integrate, where the scaled and filtered DC input is connected to the A/D integrator. The fourth and fifth steps, called "reference integrate", connects an internal reference (GMR) to the integrator input with a polarity to cause the output to "disintegrate" back toward the reference zero voltage.

2.14 Data Display - After nul detect, the display counter storage register in the APC is updated with the latest input values. The uC via the digital interface checks this register and stores the value in its own memory and display the value on the LCD display. The LCD also displays the appropriate annunciators with respect to the function selected, range and decimal position.

1) V : Volts

2) mV : Millivolts

3) A : Amps

4) mA : Milliamps

5) Ω : Ohms

6) K : Kilohms

7) M : Megohms

8) AC : AC volts or amps

9) ⎍⎍⎍ : Logic function

10) ⚡ : ~~200~~ 20 V volt or higher range

11) - : Input has negative polarity

12) + : Input has a positive polarity

13) OL : Meter is in overrange condition

14) The decimal point positions are as follows:

VOLTS	OHMS	CURRENT	DIODE
200.0 mV	200.0	2.000 mA	2.000 V
2.000 V	2.000 K	20.00 mA	
20.00 V	20.00 K	200.0 mA	
200.0 V	200.0 K	2.000 A	
2000 V	2.000 M	20.00 A	
	20.00 M		

15) A slowly blinking decimal point indicates low battery condition.

16) A rapidly blinking decimal point indicates an OL condition and is displayed with an "OL" and the meter is in range lock.

17) Annunciators 1-7 and 10 blink when in range lock.

2.15 MICROCOMPUTER (uC) OPERATION - The microcomputer serves two major purposes. The first is to organize and control the APC's functions according to the meter function selected as read thru K0 and K3 input ports. The second is to drive the LCD display.

2.16 V/F CONVERTER - The voltage to frequency converter (V/F) has one primary purpose which is to make the time needed for autoranging as short as possible. With the V/F the uC, knows a maximum of 40 milliseconds after an overrange or underrange condition occurs.

2.20 AC VOLTAGE MEASUREMENT

The AC converter used in this meter is an AC-coupled averaging converter. When the AC voltage function is selected, the AC input is scaled in the same manner as done in the DC voltage function and is then routed to the AC converter via the switches AC and AC (see fig.2). The AC converter converts its input to an equivalent DC output, which becomes the scaled DC input to both the NMF and V/F converter.

2.30 OHMS MEASUREMENT

Resistance measurements are made with a ratio technique where an unknown resistance is compared with an internal resistance standard. Due to the negligible resistance loading of the meter, the ratio of the the two resistors in circuit is equal to the ratio of their respective voltage drops.

NOTE: If the meter is in the manually selected ohms range, an overload condition is shown by an "OL" in the display with a flashing decimal point.

2.40 DIODE TEST

The meter circuit configuration is the same as for ohms (see fig. 3). When the meter is selected for diode test, switches SR$ and 20M are closed. This function does NOT autorange. Full scale voltage is +2.000 V DC. Typical silicon diodes will read 600 to 700 mV. If the diode is connected so that it is reversed biased and the reverse leakage is greater than 2 K ohm the meter will display "OL".

2.50 CURRENT MEASUREMENTS

For current measurements to 200 mA AC or DC, connect the current source betwween the mA and COM terminals. For currents to 10 amperes AC or DC, connect the current source between A and COM.

The current is routed through the internal 10 ohm or 0.01 ohm shunt, which causes a voltage drop across that selected shunt. This voltage is proportional to the applied current and is the voltage used by the meter to derive the current reading.

Depending upon the range selected, the input amplifier will be configured so that its full scale output will be 200 mV or less

2.60 POWER SUPPLIES

The VDD (+6V), VD2 (+4V) and VSS (-5V) power supplies are off when the meter is off. Power taken directly from the 9 volt battery keeps a monitor circuit powered so as to detect a "power on" command when the ON/C button is pressed. When the meter is on and if the meter does not experience a function or range change for 55 min. approx., the uC will advise the APC to turn the meter off.

2.70 VOLTAGE REFERENCE

The voltage reference used by the meter is generated from VSS by use of a stable band gap voltage reference diode VR5. The reference voltage of VR5 is about 1.22 volts and is scaled to about -1.00 volt, which becomes the meter reference, RV. Fine adjustment of RV for meter calibration is accomplished by adjustment of the 10 K potentiometer, R12.

3.00 SPECIAL FEATURES

3.10 Range Lock/Range Step - Range lock is entered by pressing the range button. To change ranges (range step) again press the range button which will cause the meter to uprange. The meter will always uprange to the next higher range unless it is in the highest range, where the meter will fall back to the lowest range.

3.20 Beeper/Analog Tone - The beeper is used for the following:

1) Confirmation of a power on command when the meter is off and the ON/C button is pressed.

Two 40 millisecond, 1,875 Hz beeps.

2) Confirmation of ;

a) Tone or logic function selection, range lock or clear command.

One 40 millisecond, 1,875 Hz beep.

b) Auto range selection, giving;

Two beeps from 20 V to 200 V range transition and

Three beeps from 200 V to 2000 V range

c) Range lock function giving;

One beep for every range change

3) Detection of continuity (<100 ohm) when in diode test continuity function.

One 200 millisecond, 1,875 Hz beep

4) When the tone function enabled the beeper will output a continuous tone that varies with the input magnatude, analog tone.

5) Detection of a positive logic transistion when in logic mode.

One 40 millisecond, 1,875 Hz beep

3.30 LOGIC PROBE

The logic probe feature is AC coupled and responds only to positive transitions < +2.6 Volts. This is independent of of range. Each transistion detected will cause the beeper to outputa 40 millisecond, 1,875 HZ beep. In the event the transitions occur at a rate of 25 or more per second, the beeper will output a continuous 1,875 Hz tone.

The logic feature is usable only when the meter is in the DC volts function and when selected. The LCD annunciates this by displaying the "⎍⎍" symbol.

4.00 RECOMMENDED TEST/REPAIR EQUIPMENT

Due to the meters vulnerability to electrostatic discharge (ESD) it is strongly recommended that all the following test and repair equipment be incorporated during the repair of any HD150 series repair attempt.

Fluke 5101 Calibrator
Rotek High current adaptor
Beckman Industrial 350
Ionizer
Pace Craft 100 or Ungar 4700 reflow
Beckman Service Head Retainer Tool

4.10 Functional Check

1. Press and hold the ON/C button.

   Observe that all segments on LCD are lit (fig. xx).

2. Set the function select to the (V ⎓) position.

   Observe that the LCD count is 00.0 mV +/-00.2 counts.

3. Insert test leads into the V- and COM input jacks.

   Observe the following voltage levels as the calibrator source voltages are changed to the indicated outputs.

DC VOLTS (V ⎓) Function

4.14 Auto up ranging test A. low voltage

Calibrator Output	HD153 Min	HD153 Max	HD152 Min	HD152 Max	HD151 Min	HD151 Max
A] 0.19 V DC	+189.6	+190.4	+189.3	+190.7	+189.1	+190.9
B] 1.90 V DC	+1.896	+1.904	+1.893	+1.907	+1.891	+1.909
C]-1.90 V DC	-1.895	-1.905	-1.892	-1.908	-1.890	-1.910
D] 19.0 V DC	+18.96	+19.04	+18.93	+19.07	+18.91	+19.09

4.15 Auto up ranging test B. high voltage

Observe that a high voltage warning symbol " " appears in the upper left hand corner of the LCD and that a "V" appears in the upper right corner before proceeding. You should hear a short beep as the meter transistions to the higher voltage.

E] 190 V DC	+189.6	+190.4	+189.3	+190.7	+189.1	+190.9
F] 1000 V DC	+ 997	+ 1003	+ 996	+ 1004	+ 995	+ 1005

a] Only the "mV" characters on LCD
b] Only the "V" characters on LCD
c] Observe the "+" sign changed to a "-" sign
d] Observe only the "V" character on LCD

4.16 Manual ranging and overrange (OL) detector test

NOTE: Min and Max limits do not apply to this test. Observe only the decimal point location.

1.9 V DC 1.XXX

1. Depress the RANGE switch twice.

   Observe the flashing voltage sign "V" in the upper right corner of LCD. The meter is now in the Manual Ranging Mode, 2 V range.

2. Depress the RANGE switch again.

   Observe the meter is now in the 20 V range (1.XX V)

3. Depress the RANGE switch again.

   Observe the meter is now in the 200V range (01.X V)

4. Depress the RANGE switch again.

   Observe the meter is now in the 1500V range (00X V)

5. Depress the RANGE switch again.

   Observe the meter is now in the 0.2V range (00.0mV)

AC VOLTS (V ~) Function (50 HZ to 1 KHZ)

Set the function select switch to the V position. Insert the test leads from the calibrator into the V- and COM input jack.

4.17 1 K Hz and 50 Hz frequency and auto down range test

Calibrator Output	HD153 Min	HD153 Max	HD152 Min	HD152 Max	HD151 Min	HD151 Max
A] 1000 VAC 1K	989	1011	982	1018	982	1018
B] 190 VAC 1K	188.9	191.1	188.0	192.0	188.0	192.0
C] 19.0 VAC 1K	18.89	19.11	18.80	19.20	18.80	19.20
D] 1.90 VAC 1K	1.883	1.917	1.868	1.932	1.868	1.932
E] 0.19 VAC 50	188.9	191.1	188.0	192.0	188.0	192.0

a] Only the " ", "AC " and "V" characters on LCD
b] Only the " ", "AC " and "V" characters on LCD
c] Only the "AC " and "V" characters on LCD
d] Only the "AC " and "V" characters on LCD
e] Only the "AC " and "mV" characters on LCD

DC AMPS (A ⎓) FUNCTION

4.18 Voltage Burden Test Measurements ⇒ DELETE 4.18

1. Set the function selector to the A position

NOTE: Step 2 and 3 performed together.

2. Insert test leads from the calibrator into the "mA" and "COM" input jacks and observe the following readouts.

3. Measure voltage burden with another voltmeter, its test leads MUST be placed as close as possible to the "mA" and "COM" input jacks. The voltage burden spec is 2.8 V Max. for all models.

Calibrator Output	HD153 Min	HD153 Max	HD152 Min	HD152 Max	HD151 Min	HD151 Max
190 mA DC	189.0	191.0	188.7	191.3	188.1	191.9

Observe that only the "mA" characters are on LCD

NOTE: Steps 4 and 5 are performed simultaneously.

4. Insert the test leads from the calibrator into the "10A" and "COM" input jacks and observe the following current level readouts.

5. Measure voltage burden with another voltmeter, its test leads must be placed as close as possible to to the "10A" and "COM" input jacks. The voltage burden spec is 750 mV Max. for all models.

Calibrator Output	HD153 Min	HD153 Max	HD152 Min	HD152 Max	HD151 Min	HD151 Max
ROTEK 10 A DC	9.89	10.11	9.89	10.11	N/A	N/A

Observe that only the "A" characters are on LCD

6. Remove the voltage burden measuring equiptment.

AC AMPS (A ~) FUNCTION (60 Hz)

start ~~4.19~~ 4.18

1. Set the function selector tothe A ~ position.

2. Insert the test leads from tha calibrator into the "mA" and "COM" input jacks and observe the following current level readouts.

Calibrator Output	HD153 Min	HD153 Max	HD152 Min	HD152 Max	HD151 Min	HD151 Max
190 mA AC 60 HZ	188.0	192.0	187.4	192.6	187.3	192.7

Observe that the "AC " and "mA" characters are on LCD

3. Insert the test leads from the calibrator into the "10A" and "COM" input jacks and observe the following current level readouts.

Calibrator Output	HD153 Min	HD153 Max	HD152 Min	HD152 Max	HD151 Min	HD151 Max
A AC 60 HZ	.98	1.02	.96	1.04	N/A	N/A

Observe that the "AC " and "A" characters are on LCD

See Hand to DMM Sec. Man.

Start

BEEPER LOGIC (⚡/⎍⎍⎍) FUNCTION (In DCV Range)

4.22
~~4.22~~ Beeper Test

1. Set the function selector to the V ⎓ position.

2. Insert the test leads from the calibrator into the "V-Ω" and "COM" input jacks. Depress the (⚡/⎍⎍⎍) switch once and observe the following types of sounds with the source indicated.

Calibrator Output	HD153	HD152	HD151
1 V DC	Beeper Tone	N/A	N/A
1.1 V DC	Higher Pitch	N/A	N/A

4.23
~~4.24~~ Logic Test

3. Depress the (⚡/⎍⎍⎍) a second time.

1.1 V AC (1 K Hz) Logic symbol appears on LCD no tone heard.

1.6 V AC (1 K Hz) Beeper tone sounded all models.

OHMS (Ω) FUNCTION TEST

4.19
~~4.20~~ Ohms Function Test

1. Set the function selector to the ( ) position.

2. Insert the test leads from the calibrator into the "V- " and "COM" input jacks and observe the following resistance levels.

	Calibrator Output	HD153 Min	HD153 Max	HD152 Min	HD152 Max	HD151 Min	HD151 Max
A]	100 Ohms	99.5	100.5	99.4	100.6	99.4	100.6
B]	100 K Ohms	99.5	100.5	99.4	100.6	99.4	100.6
C]	10 M Ohms	9.89	10.11	9.85	10.15	9.85	10.15

a] Only the " " character is on the LCD

b] Only the "K " character is on the LCD

c] Only the "M " character is on the LCD

DIODE CONTINUITY (⊣◀))) FUNCTION

4.20
~~4.21~~ Diode Test

1. Set the function selector to the ⊣◀)) position.

2. Insert the test leads from the calibrator into the "V-Ω" and "COM" input jacks and observe the following voltage level readouts.

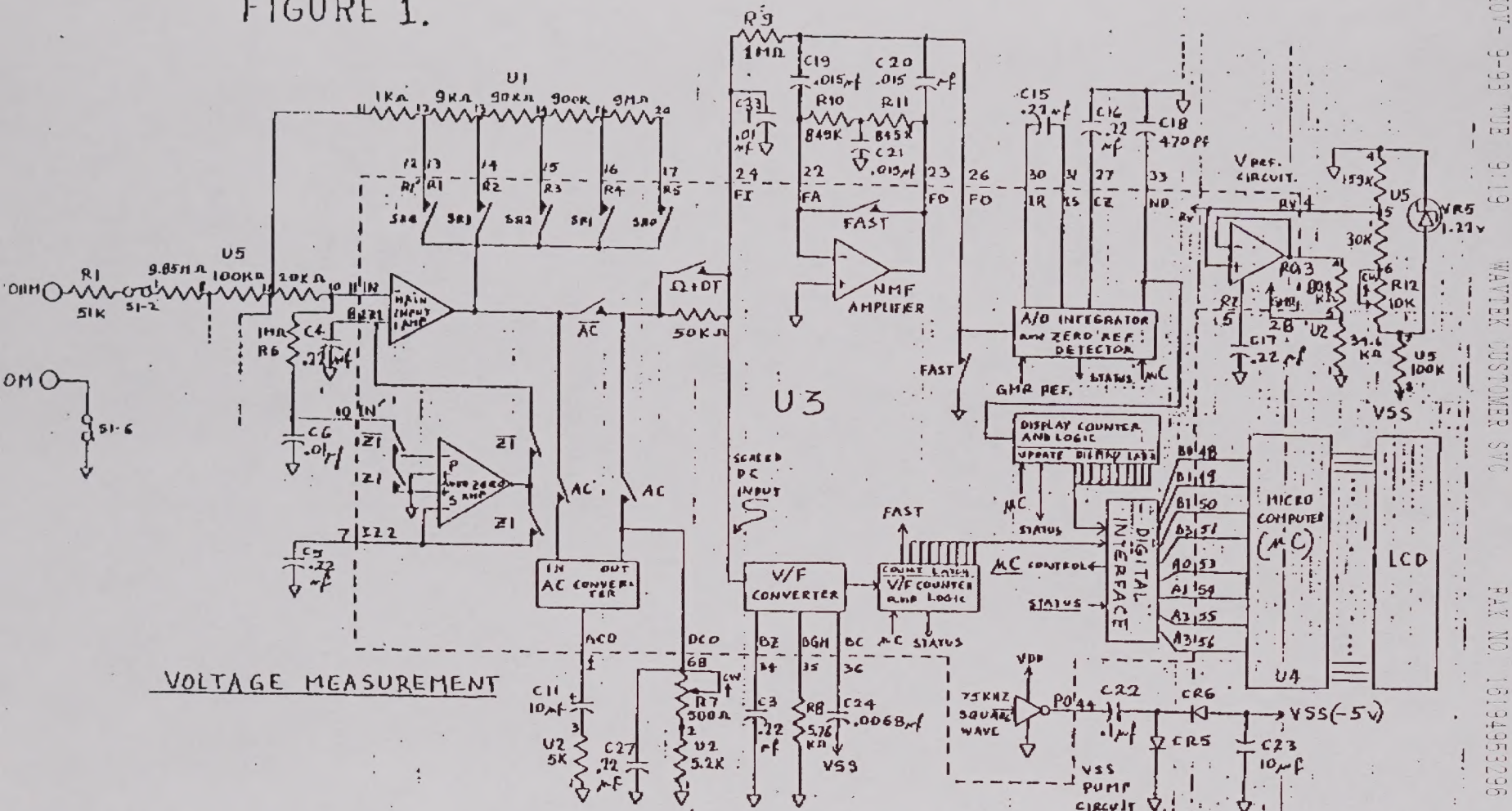
Calibrator Output	HD153 Min	HD153 Max	HD152 Min	HD152 Max	HD151 Min	HD151 Max
1 K Ohms	+.994	+1.006	+.994	+1.006	+.994	+1.006

Observe that only the "V" is on the LCD

4.21
~~4.22~~ Continuity Test

Calibrator Output	HD153	HD152	HD151
100 Ohms	Short beep.	Short beep.	Short beep.

FIGURE 1.



VOLTAGE MEASUREMENT

ACCOPRESS®

25970	YELLOW
25971	BLACK
25972	LIGHT BLUE
25973	DARK BLUE
25974	LIGHT GRAY
25975	LIGHT GREEN
25976	DARK GREEN
25977	TANGERINE
25978	RED
25979	EXECUTIVE RED

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